Phenolic Impregnated Carbon Ablator (PICA) Gap Filler for Heat Shield Assemblies

Fiber Materials, Inc.

Technical Abstract

During this program, Fiber Materials, Inc. (FMI) will develop practical methods for preparing Phenolic Impregnated Carbon Ablator (PICA) materials for joining thermal protection system segments and penetrations of the heat shield assembly. Current and future mission flight environments and designs, such as those for Mars Science Laboratory Aeroshell (MSLA) and anticipated for New Frontiers and Mars EDL missions, will be assessed. Capability of the developed solution(s) will address mechanical and thermal robustness, and performance under representative mission heating environment. The Phase 1 program evaluated candidate joining and gap-fill materials, and assessed joining design approaches for cost effective manufacturability and assembly. Material joining design, assembly methodology and material test performance was documented. The Phase 2 program will utilize materials developed during the Phase 1 program to test performance under representative environment(s). A down-selected material-joining approach will result in the design and fabrication of a mission-specific PICA sub-assembly. The prototype sub-assembly will demonstrate assembly methods and the prototype materials will be utilized for characterization and performance testing. The proposed materials, designs and methods are TRL <=3. It is anticipated that TRL=>6 will be achieved at the conclusion of a successful phase 2 program.

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2009 Phase II
Proposal X9.01-8952

Ablative Thermal Protection Systems

Computational Tool for Coupled Simulation of Nonequilibrium Hypersonic Flows with Ablation

CFD Research Corporation

Technical Abstract

The goal of this SBIR project is to develop a predictive computational tool for the aerothermal environment around ablation-cooled hypersonic atmospheric entry vehicles. This tool is based on coupling the relevant physics models to the LeMANS code for hypersonic flows and to the MOPAR code for material response, both developed by the University of Michigan. In Phase I of this project, we developed an efficient, high-fidelity 3-D radiation transfer equation (RTE) solver based on the Modified Differential Approximation (MDA). The MDA method was shown to be accurate over at least three orders of magnitude variation in medium optical thickness, typical in entry hypersonic flows. The coupled LeMANS-radiation code was demonstrated for Stardust and IRV2 configurations, while the coupled LeMANS-MOPAR code was validated for the Passive Nosetip Technology (PANT) experiment [1], successfully establishing feasibility. In Phase II, the primary focus is to advance the flow and ablation modeling capabilities of the LeMANS/MOPAR codes by including innovative models for: (1) Non-equilibrium surface thermochemistry; (2) Non-equilibrium pyrolysis chemistry; and (3) Non-gray, non-equilibrium radiation. All models will be implemented in a modular manner with particular attention paid to their coupling interfaces to facilitate easy coupling to a computational aerothermodynamics code of interest to NASA such as DPLR. The tool will be validated and applied to ablation-cooled re-entry flow problems relevant to NASA such as the Stardust capsule.

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